In [1]:

```python
import unidecode
```

In [2]:

```python
unidecode.unidecode
```

Out[2]:

```
<function unidecode.unidecode_expect_ascii(string: str, errors: str = 'ignore', replace_str: str = '?') ->
str>
```

In [3]:

```python
import string
import random
import torch
import torch.nn as nn
import matplotlib.pyplot as plt
import torch.nn.functional as F
```

Prepare for Dataset

In [4]:

```python
all_chars       = string.printable
n_chars         = len(all_chars)
file            = open('./linux.txt').read()
file_len        = len(file)

print('Length of file: {}'.format(file_len))
print('All possible characters: {}'.format(all_chars))
print('Number of all possible characters: {}'.format(n_chars))
```

```
Length of file: 6546665
All possible characters: 0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ!"#$%&'()*+,-./:;<=
>?@[\]^_`{|}~

Number of all possible characters: 100
```

In [5]:

```python
# Get a random sequence of the Shakespeare dataset.
def get_random_seq():
    seq_len     = 128  # The length of an input sequence.
    start_index = random.randint(0, file_len - seq_len)
    end_index   = start_index + seq_len + 1
    return file[start_index:end_index]

# Convert the sequence to one-hot tensor.
def seq_to_onehot(seq):
    tensor = torch.zeros(len(seq), 1, n_chars)
    # Shape of the tensor:
    #     (sequence length, batch size, classes)
    # Here we use batch size = 1 and classes = number of unique characters.
    for t, char in enumerate(seq):
        index = all_chars.index(char)
        tensor[t][0][index] = 1
    return tensor

# Convert the sequence to index tensor.
def seq_to_index(seq):
    tensor = torch.zeros(len(seq), 1)
    # Shape of the tensor:
    #     (sequence length, batch size).
    # Here we use batch size = 1.
    for t, char in enumerate(seq):
        tensor[t] = all_chars.index(char)
    return tensor

# Sample a mini-batch including input tensor and target tensor.
def get_input_and_target():
    seq    = get_random_seq()
    input  = seq_to_onehot(seq[:-1])      # Input is represented in one-hot.
    target = seq_to_index(seq[1:]).long() # Target is represented in index.
    return input, target
```

Choose a Device

In [6]:

```
# If there are GPUs, choose the first one for computing. Otherwise use CPU.
device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
print(device)
# If 'cuda:0' is printed, it means GPU is available.
```

```
cuda:0
```

Network Definition

In [43]:

```
class Net(nn.Module):
    def __init__(self):
        # Initialization.
        super(Net, self).__init__()
        self.input_size  = n_chars   # Input size: Number of unique chars.
        self.hidden_size = 100      # Hidden size: 100.
        self.output_size = n_chars   # Output size: Number of unique chars.

        ###### To be filled ######
        ###### To be filled ######
        self.rnn_cell = nn.RNNCell(self.input_size, self.hidden_size)
        self.linear = nn.Linear(self.hidden_size, self.output_size)
        self.leaky_relu = nn.LeakyReLU()
        self.selu = nn.SELU()
    def forward(self, input, hidden):
        """ Forward function.
              input:  One-hot input. It refers to the x_t in homework write-up.
              hidden: Previous hidden state. It refers to the h_{t-1}.
            Returns (output, hidden) where output refers to y_t and
                     hidden refers to h_t.
        """
        # Forward function.
        #hidden = torch.sigmoid(self.rnn_cell(input, hidden))
        #hidden = torch.relu(self.rnn_cell(input, hidden))
        #hidden = torch.tanh(self.rnn_cell(input, hidden))
        #hidden = self.leaky_relu(self.rnn_cell(input, hidden))
        #hidden = self.selu(self.rnn_cell(input, hidden))
        hidden = F.silu(self.rnn_cell(input, hidden))
        output = self.linear(hidden)

        return output, hidden

    def init_hidden(self):
        # Initial hidden state.
        # 1 means batch size = 1.
        return torch.zeros(1, self.hidden_size).to(device)

net = Net()     # Create the network instance.
net.to(device)  # Move the network parameters to the specified device.
```

Out[43]:

```
Net(
  (rnn_cell): RNNCell(100, 100)
  (linear): Linear(in_features=100, out_features=100, bias=True)
  (leaky_relu): LeakyReLU(negative_slope=0.01)
  (selu): SELU()
)
```

Training Step and Evaluation Step

In [44]:

```
# Training step function.
def train_step(net, opt, input, target):
    """ Training step.
        net:    The network instance.
        opt:    The optimizer instance.
        input:  Input tensor.  Shape: [seq_len, 1, n_chars].
        target: Target tensor. Shape: [seq_len, 1].
    """
    seq_len = input.shape[0]    # Get the sequence length of current input.
    hidden = net.init_hidden()  # Initial hidden state.
    net.zero_grad()             # Clear the gradient.
    loss = 0                    # Initial loss.

    for t in range(seq_len):    # For each one in the input sequence.
        output, hidden = net(input[t], hidden)
        loss += loss_func(output, target[t])

    loss.backward()             # Backward.
    opt.step()                  # Update the weights.

    return loss / seq_len       # Return the average loss w.r.t sequence length.
```

In [45]:

```
# Evaluation step function.
def eval_step(net, init_seq='W', predicted_len=100):
    # Initialize the hidden state, input and the predicted sequence.
    hidden        = net.init_hidden()
    init_input    = seq_to_onehot(init_seq).to(device)
    predicted_seq = init_seq

    # Use initial string to "build up" hidden state.
    for t in range(len(init_seq) - 1):
        output, hidden = net(init_input[t], hidden)

    # Set current input as the last character of the initial string.
    input = init_input[-1]

    # Predict more characters after the initial string.
    for t in range(predicted_len):
        # Get the current output and hidden state.
        output, hidden = net(input, hidden)

        # Sample from the output as a multinomial distribution.
        predicted_index = torch.multinomial(output.view(-1).exp(), 1)[0]

        # Add predicted character to the sequence and use it as next input.
        predicted_char  = all_chars[predicted_index]
        predicted_seq  += predicted_char

        # Use the predicted character to generate the input of next round.
        input = seq_to_onehot(predicted_char)[0].to(device)

    return predicted_seq
```

Training Procedure

In [46]:

```python
# Number of iterations.
# NOTE: You may reduce the number of training iterations if the training takes long.
iters       = 20000  # Number of training iterations.
print_iters = 100    # Number of iterations for each log printing.

# The loss variables.
all_losses = []
loss_sum   = 0

# Initialize the optimizer and the loss function.
opt       = torch.optim.Adam(net.parameters(), lr=0.005)
loss_func = nn.CrossEntropyLoss()

# Training procedure.
for i in range(iters):
    input, target = get_input_and_target()            # Fetch input and target.
    input, target = input.to(device), target.to(device) # Move to GPU memory.
    loss      = train_step(net, opt, input, target)   # Calculate the loss.
    #loss_sum += loss                                  # Accumulate the loss.
    loss_sum += loss.item()
    # Print the log.
    if i % print_iters == print_iters - 1:
        print('iter:{}/{} loss:{}'.format(i, iters, loss_sum / print_iters))
        print('generated sequence: {}\n'.format(eval_step(net)))

        # Track the loss.
        all_losses.append(loss_sum / print_iters)
        loss_sum = 0
```

```
        }
}

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generated sequence: WADE C3X, 001 0;

        /* Sha

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 * LOT)  Dashrocy.ma

iter:4399/20000 loss:1.9546347057819367
```
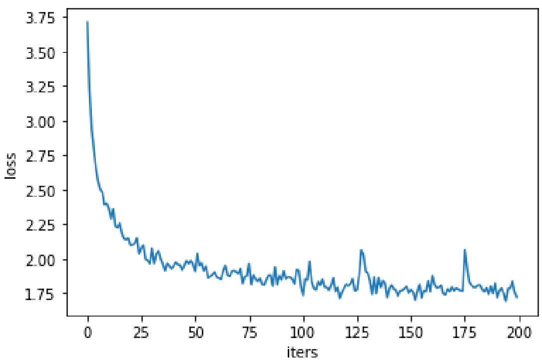

Training Loss Curve

In [47]:

```python
plt.xlabel('iters')
plt.ylabel('loss')
plt.plot(all_losses)
plt.show()
```



Evaluation: A Sample of Generated Sequence

In [48]:

```
print(eval_step(net, predicted_len=600))
```

```
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                 */
                }
        }
        if (!camploreize        = (!must(&mamk_lock_reso);
        entry_irq_wake_lep_t)
```

In [ ]:

```

```

In [ ]:

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```